AD-A031 672 ARMY AVIATION TEST BOARD FORT RUCKER ALA F/G 1/3

PRODUCT-IMPROVEMENT TEST OF OH-6A CARGO COMPARTMENT SOUNDPROOFI--ETC(U)

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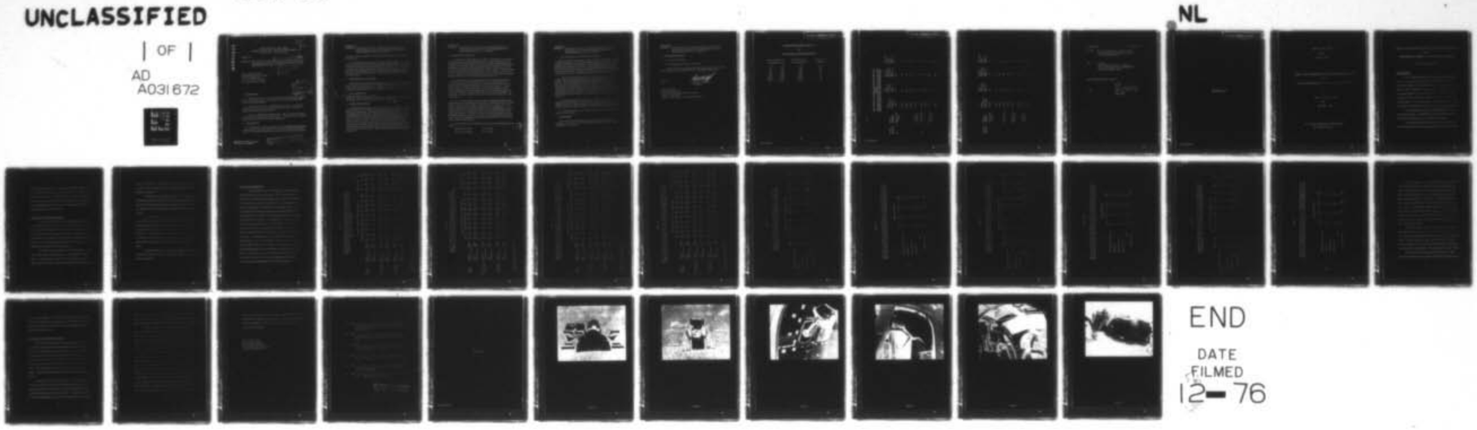

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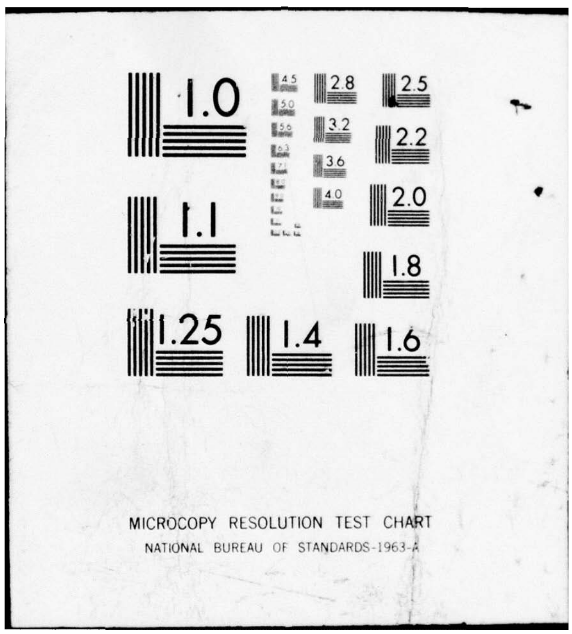
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DEPARTMENT OF THE ARMY
UNITED STATES ARMY AVIATION TEST BOARD
Fort Rucker, Alabama 36360

STEBG-TD (6) (11) 21 JUN 1968

SUBJECT: Final Report of Test, "Product-Improvement Test of OH-6A Cargo Compartment Soundproofing Installation." USATECOM Project No. 4-6-0251-12

(9) Final rept.

(12) 37p.

Commanding General
US Army Materiel Command
ATTN: AMCPM-LH
P.O. Box 209, Main Office
St. Louis, Missouri 63166

1. REFERENCES

a. HEL Standard S-1-63B, US Army Human Engineering Laboratories, June 1965, subject: "Maximum Noise Level for Army Materiel Command Equipment."

b. Final Report of Test, USATECOM Project No. 4-6-0250-05, "Confirmatory Test (Type I) of the OH-6A Helicopter," US Army Aviation Test Board, 20 April 1967.

c. Letter, AMSTE-BG, Headquarters, US Army Test and Evaluation Command, 7 February 1968, subject: "Test Directive, Product Improvement Test OH-6A Prototype Hardware."

2. BACKGROUND

a. Confirmatory testing of production-model OH-6A Helicopters conducted by the US Army Aviation Test Board (USAAVNTBD) (reference 1b) indicated that OH-6A cabin-area noise levels exceeded the

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maximum limit as specified in the Military Characteristics (MC's) (90 decibels).

b. The Cayuse Project Manager requested that Hughes Tool Company, Aircraft Division, develop a soundproofing assembly which would meet the noise level criteria established by reference 1a. Inclosure 1 is a table which extracts pertinent portions of these criteria. The Cayuse Project Manager further requested that the USAAVNTBD test the improved soundproofing which is designed to diminish the cabin-area noise level.

3. DESCRIPTION OF MATERIEL

The improved soundproofing installation is a 13-piece, blanket-type assembly which attaches to the cabin area of the aircraft by means of snap- and Velcro-type fasteners. Figures 1, 2, 4, and 5 describe the relative size and positioning of the equipment in the aircraft.

4. TEST OBJECTIVE

The objective of this report was

~~To~~ determine the ability of the improved cargo compartment soundproofing to lower noise levels to acceptable limits.

5. SCOPE AND METHOD

The USAAVNTBD tested a prototype improved soundproofing installation at Fort Rucker, Alabama, and Apalachicola, Florida, for 30 days during the periods 12-18 March 1968 and 12 May to 3 June 1968. Testing was interrupted from March to May 1968 while the test aircraft (OH-6A, S/N 65-12921) underwent environmental testing at Eglin Air Force Base, Florida. The aircraft, with test soundproofing installed, was flown a total of 60 hours of which 10 hours were flown with all four crew and cargo doors removed. On 18 March 1968, personnel from the US Army Aeromedical Research Unit (USAARU) conducted tests to determine the effects of the improved soundproofing on the noise level in the aircraft. Their complete report is contained in inclosure 3.

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6. SUMMARY OF RESULTS

a. Comparison tests (tables 1 through 4, inclosure 3) of recorded aircraft noise levels with and without the improved soundproofing installed indicate that the presence of the improved soundproofing significantly lowers cabin-area noise intensity particularly in the medium- to high-sound-frequency range (1,000 to 16,000 cycles per second). In the low-frequency range, USAARU personnel report: "that the soundproofing material had very little effect... These results are to be expected. This type of sound treatment (the use of sound absorbent padding) does not yield much low frequency attenuation."

b. Comparison of test results against the criteria established in reference 1a indicates that maximum noise level limits for the improved soundproofing assembly were exceeded twice and by only one decibel each time while operating the aircraft at a 65 p.s.i. torque power setting. Comparison of test results for the standard-type soundproofing (reference 1b) against the same criteria and under the same test conditions indicates that noise levels for this assembly exceeded the maximum limits 18 times by as much as 12 decibels. (See inclosure 2.)

c. Minor modification of the aft cargo compartment bulkhead was required to permit installation of the improved soundproofing assembly. Figure 3 shows several of the snap-type fasteners which were positioned with the aid of a template supplied by the manufacturer. Figure 5 shows the location of several of the smaller soundproofing sections located in the crew compartment which are also secured in place by snap-type fasteners. A total of 10 man-hours was required to install the additional fastening devices. Several of the Velcro-type fasteners used to secure the standard soundproofing installation were also used in the improved installation.

d. Total weights of the standard and improved assemblies were as follows:

Standard assembly	15.0 pounds
Improved assembly	16.3 pounds

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e. The following design deficiency was found:

Chafing between the plastic forming material on the interior of the soundproofing assembly and the temperature-sensing switch on the forward side of the main transmission caused sufficient damage to the switch to necessitate replacement. Reforming the plastic material to allow clearance between the forming material and the switch should correct the deficiency. (Figure 6 depicts the lower portion of the main transmission with its soundproofing section partially removed.)

f. The test aircraft was flown for 10 hours with the improved soundproofing installed and with all four crew and cargo doors removed. The soundproofing assembly remained properly fastened at indicated airspeeds (IAS) up to 80 knots. However, above 80 knots IAS, outside air entering the cargo compartment caused excessive flapping of all soundproofing sections, and at 100 knots IAS, the portion covering the aft cargo compartment bulkhead became unfastened. It is apparent that 80 knots IAS is the maximum airspeed for operation of the aircraft with the improved soundproofing installed and the doors removed.

g. Repeated installation and removal of the prototype soundproofing equipment resulted in a small degree of seam failure in the cover material in the two larger sections. It is anticipated that production models of this new equipment will be constructed with stronger seams.

h. No unsafe features were noted, and no special safety precautions were necessary.

7. CONCLUSION

The improved soundproofing assembly should be suitable for installation on current production OH-6A Helicopters when the design deficiency is corrected.

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8. RECOMMENDATIONS

It is recommended that:

a. The design deficiency be corrected.

b. After correction of the design deficiency, the improved soundproofing assembly be adopted for use on the OH-6A Helicopter.

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DAVID M. KYLE
Colonel, Artillery
President

Copy furnished:
Commanding General
US Army Test and Evaluation Command
ATTN: AMSTE-BG
Aberdeen Proving Ground, Maryland 21005

Maximum Steady-State Noise Level

for

Army Materiel Command Equipment

Octave Band Limits (c.p.s.)	Center Frequency (c.p.s.)	Noise Level (db)
44 - 87	63	119
87 - 175	125	114
175 - 350	250	107
350 - 700	500	99
700 - 1,400	1,000	91
1,400 - 2,800	2,000	89
2,800 - 5,600	4,000	89
5,600 - 11,200	8,000	91

INCLOSURE 1

<u>List of Cabin Locations and Sound Frequencies</u>
<u>Where</u>
<u>Maximum Noise Level Limits Were Exceeded</u>
<u>(Standard Production Soundproofing Assembly)</u>

Torque (p.s.i.)	Cabin Location	Sound Frequency (c.p.s.)	HEL Standard S-1-63A (db)	Extent Standard Exceeded (db)	Recorded Noise Level (db)
20	Right trans-mission	500	99	101	2
		1,000	91	93	2
		2,000	89	95	6
		4,000	89	94	5
	Left trans-mission	2,000	89	92	3
65	Pilot's head	2,000	89	92	3
		4,000	89	93	4
	Right trans-mission	500	99	103	4
		2,000	89	101	12

INCLOSURE 2

Torque (p.s.i.)	Cabin Location	Sound Frequency (c.p.s.)	HEL Standard S-1-63A (db)	Extent Standard Exceeded (db)	Recorded Noise Level (db)
	Left transmission	1,000	91	94	3
		2,000	89	97	8
		4,000	89	100	11
	Pilot's head	2,000	89	92	3
		4,000	89	90	1
	Right transmission	2,000	89	94	5
		4,000	89	97	8
	Left transmission	2,000	89	94	5
		4,000	89	99	10

USAARU-BSD 22 May 1968

SUBJECT: Overall and Octave-Band Noise Attenuation Characteristics of a Soundproofing Assembly in an Army OH-6A Helicopter.

TO: President
United States Army Aviation Test Board
ATTN: Major Gerald W. Orr (STEBG-TD-A)
Fort Rucker, Alabama 36360

Subject report is attached as requested.

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ROBERT W. BAILEY
LTC., MSC
Commanding

USAARU Report

INCLOSURE 3

USAARU LETTER REPORT

Dated:

22 May, 1968

OVERALL AND OCTAVE-BAND NOISE ATTENUATION CHARACTERISTICS OF A SOUNDPROOFING ASSEMBLY IN AN ARMY OH-6A HELICOPTER

By

Robert T. Camp, Jr., DAC

and

Igor Boris, SP-5

U. S. ARMY AEROMEDICAL RESEARCH UNIT

Fort Rucker, Alabama

OVERALL AND OCTAVE-BAND NOISE ATTENUATION CHARACTERISTICS
OF A
SOUNDPROOFING ASSEMBLY IN AN ARMY OH-6A HELICOPTER

INTRODUCTION.

The U. S. Army Aviation Test Board requested that the Aeromedical Research Unit determine the sound attenuation characteristics of a prototype soundproofing assembly in an Army OH-6A helicopter. In a memorandum dated 27 March, 1968, to USAARU, the Test Board stated: "Initial production model soundproofing assemblies installed in OH-6A aircraft did not meet sound level requirements outlined in the Military Specifications for the Light Observation Helicopter (LOH). The new soundproofing assembly was produced by the Hughes Tool Company (Aircraft Division) and was designed to meet these specifications.

"The Cayuse project manager requested USATECOM to test the new soundproofing equipment. USATECOM directed the USAAVNTBD to test the equipment and assign Project Number 4-6-0251-12 to the effort.

"The soundproofing assembly is designed to cover the aft portion of the cargo compartment, the lower exposed proportion of the main transmission's

drive shaft and main transmission. Furthermore, one section is attached to the bulkhead between the pilot and co-pilot's position. The USAARU test report will be attached to the USAAVNTBD final test report as an enclosure. Therefore, rather than publish weight in basic dimensions of the soundproofing in the USAARU and Test Board reports, it will suffice to publish these basic data only in the Test Board's report."

PROCEDURE AND INSTRUMENTATION.

The attenuation characteristics of the soundproofing assembly were determined by recording internal noise with and without the assembly installed. Samples of noise were obtained from three positions. The microphone was placed at head level at the right and left sides of the transmission and the right pilot's position. First, recordings were taken under various operational conditions with the soundproofing assembly installed. Then a second series were recorded with the soundproofing assembly removed.

The samples of noise were recorded on a Nagra III precision portable magnetic tape recorder which was operated at a tape speed of 15 inches per second. A calibrated Brüel & Kjaer type 3141 microphone, powered by a Brüel & Kjaer battery driven cathode follower type 2630, was fed into the line

input of the tape recorder. The precision reference sound source generated by a Brüel & Kjaer type 4220 pistonphone was recorded before and after recordings of noise samples.

The instrumentation for playback and analysis of the noise consisted of the Nagra III recorder, a Brüel & Kjaer type 2112 audiofrequency spectrometer, a Brüel & Kjaer type 2603 microphone amplifier with a Brüel & Kjaer type 1612 filter set, and two Brüel & Kjaer type 4420 statistical distribution analyzers.

The output of the tape recorder was fed into the two sets of filters, each of which was connected to a Brüel & Kjaer type 2305 level recorder. Samples of 30 seconds duration were played back through the filter sets and analyzed statistically. Each graphic level recorder was fitted with a 25 db potentiometer. The statistical analyzer divides the total dynamic range of the graphic level recorder into ten discrete levels. The division of the 25 db dynamic range into ten levels makes each class interval of the histograms 2.5 db.

Ten octave-band center frequencies were analyzed. They range from 31.5 Hz to 16K Hz. In addition, four weighting networks of the overall spectra were analyzed.

RESULTS AND DISCUSSION.

Tables I through IV contain the sound pressure levels and standard deviations derived from the spectra analyses. Each table contains data recorded with and without the soundproofing assembly. Table V through Table X show the difference values or attenuation of noise sound pressure levels between the recordings with and without the soundproofing assembly. The results among the test conditions show that at octave bands with center frequencies between 31.5 and 500 Hz there were negligible noise sound pressure level differences with and without the soundproofing. In some cases, there appear to be significant differences in the low frequency range. After a study of the over-all effect among all recording conditions, it is believed that these occasional larger difference values may be attributed to experimental artifacts. It must be pointed out that an experiment of this type is very difficult to carry out without such artifacts. There is the problem of positioning the microphone exactly in the same position in the aircraft, plus the difficulty of repeating identical flight configurations under both experimental conditions. Precautions were taken to control these errors as much as possible but, even so, the experimental errors and the probable intensity gradients within the aircraft prohibit absolute control under all conditions.

Table I

Octave-Band Analysis in Decibels of Noise Measured in the Army OH-6A Helicopter, with and without Soundproofing Material around the Transmission. The Helicopter was Operating on the Ground with Doors Closed, N_1 78%, N_2 103%, and T 20 psi.

			Octave-Band Center Frequencies in Hertz										Weighting Networks			
			31.5	63	125	250	500	1K	2K	4K	8K	16K	A	B	C	Lin.
Pilot's Position	Without Soundproofing	*M SPL	87	92	104	94	92	89	93	90	81	71	97	101	104	104
		**SD	3.4	2.6	1.9	1.4	1.2	1.0	1.9	1.4	1.0	1.1	0.9	1.1	1.3	1.4
	With Soundproofing	M SPL	88	93	105	94	92	89	87	79	69	67	94	102	105	105
		SD	3.0	2.1	1.6	1.7	1.3	1.1	4.5	2.3	0.7	0	0.8	0.9	1.1	1.3
Right Side of Transmission	Without Soundproofing	M SPL	91	99	107	100	96	97	105	97	91	79	107	103	109	109
		SD	2.8	1.0	1.3	1.3	1.1	0.9	1.2	1.4	1.0	1.3	1.2	1.2	0.5	0.6
	With Soundproofing	M SPL	88	96	105	100	93	86	84	81	71	67	96	103	106	106
		SD	3.0	1.3	1.5	1.1	1.3	0.9	1.2	1.5	1.2	0	1.2	1.3	1.2	1.1
Left Side of Transmission	Without Soundproofing	M SPL	90	97	105	97	96	98	101	97	91	78	104	106	107	107
		SD	2.3	1.1	1.5	1.5	1.3	1.2	0.9	1.1	1.3	1.3	0.2	1.2	0.6	0.9
	With Soundproofing	M SPL	88	96	103	96	94	87	85	85	74	67	95	101	104	104
		SD	2.4	1.4	1.9	1.4	1.3	1.1	1.3	2.0	0.9	0	1.0	1.3	1.3	1.2

* Mean Sound Pressure Level in Decibels
**Standard Deviation in Decibels

Table II

Octave-Band Analysis in Decibels of Noise Measured in the Army OH-6A Helicopter, with and without Soundproofing Material around the Transmission. The Helicopter was Hovering with Doors Closed, N_1 92%, N_2 103% and T 61 psi.

			Octave-Band Center Frequencies in Hertz										Weighting Networks			
			31.5	63	125	250	500	1K	2K	4K	8K	16K	A	B	C	Lin.
Pilot's Position	Without Soundproofing	*M SPL	97	90	103	96	96	89	97	89	81	72	100	103	105	106
		**SD	3.0	2.4	1.8	1.5	1.1	1.4	2.4	2.0	1.0	1.1	1.4	1.3	1.3	1.3
	With Soundproofing	M SPL	100	92	105	95	94	89	84	80	72	69	95	102	106	106
		SD	2.3	1.9	1.4	1.7	1.3	1.9	2.2	2.4	1.3	0.5	1.2	1.0	1.3	1.1
Right Side of Transmission	Without Soundproofing	M SPL	102	98	103	101	99	97	101	99	92	81	105	103	110	111
		SD	3.5	1.3	1.3	1.3	1.2	1.0	2.7	1.5	0	1.5	1.3	1.3	1.2	1.0
	With Soundproofing	M SPL	103	97	106	100	99	91	86	84	73	67	99	105	103	109
		SD	3.6	2.4	1.4	1.3	0.9	1.7	1.9	3.0	1.5	0	1.1	1.0	1.3	1.7
Left Side of Transmission	Without Soundproofing	M SPL	102	98	104	100	99	100	102	101	92	81	107	107	109	110
		SD	3.1	1.4	1.9	1.3	1.0	1.5	2.0	1.4	0.2	1.5	0.9	0.9	0.7	1.2
	With Soundproofing	M SPL	104	95	104	101	98	90	81	85	76	67	97	104	107	109
		SD	1.9	1.6	1.4	1.5	1.3	1.6	1.4	2.4	1.2	0	0.9	1.1	1.0	1.0

* Mean Sound Pressure Level in Decibels
**Standard Deviation in Decibels

Table III

Octave-Band Analysis in Decibels of Noise Measured in the Army OH-6A Helicopter, with Soundproofing (N_1 93%) and without Soundproofing (N_1 94%) Material around the Transmission. The Measurements were taken during Normal Takeoff with Doors Closed, N_2 103% and T 65 psi.

			Octave-Band Center Frequencies in Hertz										Weighting Networks			
			31.5	63	125	250	500	1K	2K	4K	8K	16K	A	B	C	Lin.
Pilot's Position	Without Soundproofing	* M SPL	101	97	101	100	96	92	97	90	82	73	101	104	107	107
		**SD	3.1	1.8	1.8	1.4	1.3	1.2	1.8	1.3	0.8	1.2	1.1	0.8	1.0	1.3
	With Soundproofing	M SPL	99	97	104	99	95	90	90	84	75	70	97	103	107	107
		SD	2.8	2.1	1.5	2.0	1.3	1.4	1.5	1.2	1.2	1.1	0.9	1.2	1.0	1.0
Right Side of Transmission	Without Soundproofing	M SPL	104	102	107	104	99	101	103	99	92	82	107	109	112	112
		SD	2.7	2.5	1.7	1.5	1.3	1.1	1.8	2.3	0.9	1.3	1.2	0.6	0.6	1.0
	With Soundproofing	M SPL	102	102	106	104	99	91	88	85	75	68	99	106	110	110
		SD	2.4	2.2	1.8	1.2	1.4	1.5	2.1	1.8	1.3	1.3	0.7	0.9	1.0	1.3
Left Side of Transmission	Without Soundproofing	M SPL	103	102	105	104	100	99	98	100	93	82	106	108	110	111
		SD	2.8	2.0	2.0	1.5	1.4	1.0	1.5	1.8	1.2	1.1	1.2	1.2	1.8	1.0
	With Soundproofing	M SPL	100	101	109	105	100	90	84	85	77	69	100	108	111	111
		SD	2.7	2.1	1.7	1.4	1.2	1.3	1.3	2.0	1.2	0.5	1.2	1.2	1.2	1.1

* Mean Sound Pressure Level in Decibels
**Standard Deviation in Decibels

Table IV

Octave-Band Analysis in Decibels of Noise Measured in the Army OH-6A Helicopter, with Soundproofing (N_1 85%) and without Soundproofing (N_1 86%) Material around the Transmission. The Measurements were taken during Normal Cruise with Doors Closed, N_2 101% and T 40 psi.

			Octave-Band Center Frequencies in Hertz										Weighting Networks			
			31.5	63	125	250	500	1K	2K	4K	8K	16K	A	B	C	Lin.
Pilot's Position	Without Soundproofing	*M SPL	100	98	101	95	95	99	86	90	82	73	99	102	105	106
		**SD	2.8	2.3	1.8	1.4	1.1	0.5	1.7	1.6	0.3	1.6	1.0	0.4	1.1	1.1
	With Soundproofing	M SPL	101	99	105	94	93	84	85	80	71	67	94	102	106	107
		SD	2.5	3.6	1.4	1.4	1.3	1.2	1.8	2.4	1.0	0.6	0.3	0.8	1.1	1.1
Right Side of Transmission	Without Soundproofing	M SPL	103	100	108	101	98	98	98	100	92	82	105	107	110	111
		SD	1.9	2.2	1.2	1.3	1.2	1.2	1.8	2.0	0.9	2.5	0.9	1.1	1.2	0.9
	With Soundproofing	M SPL	100	98	102	101	96	89	89	84	72	67	97	103	106	107
		SD	2.4	2.0	1.7	1.2	1.1	1.2	1.3	2.5	0.9	0.3	0.6	1.2	1.1	0.9
Left Side of Transmission	Without Soundproofing	M SPL	100	99	103	99	99	97	99	100	92	82	105	106	107	109
		SD	2.3	2.1	1.5	1.2	0.6	0.6	2.1	1.8	1.1	2.0	0.9	1.5	1.1	1.1
	With Soundproofing	M SPL	97	96	106	100	97	85	86	85	73	67	97	104	107	107
		SD	2.5	1.9	1.5	1.4	1.0	1.0	1.6	1.6	1.2	0.8	0.6	0.8	0.9	1.2

* Mean Sound Pressure Level in Decibels
**Standard Deviation in Decibels

Table V

Attenuation in Decibels of Soundproofing Material in an Army OH-6A Helicopter as Determined with Octave-Band Analysis of Internal Noise, at the Pilot's Position, Recorded with and without Soundproofing Material Installed.

	Octave-Band Center Frequencies in Hertz									
	31.5	63	125	250	500	1K	2K	4K	8K	16K
Operating on the Ground	-1	-1	-1	0	0	0	6	11	12	4
Hovering	-3	-2	-2	1	2	0	13	9	9	3
Normal Take Off	2	0	-3	1	1	2	7	6	7	3
Normal Cruise	-1	-1	-4	1	2	14	1	10	11	6
Total	-3	-4	-10	3	5	16	27	36.00	39.00	16
Mean Attenuation	-0.75	-1.00	-2.50	0.75	1.25	4.00	6.75	9.00	9.75	4.00

Table VI

Attenuation in Decibels of Soundproofing Material in an Army OH-6A Helicopter as Determined with Measurements of Over-all Internal Noise Spectrum with Four Weighting Networks, at the Pilot's Position, Recorded with and without Soundproofing Material Installed.

	Weighting Networks			
	A	B	C	Lin.
Operating on the Ground	3	-1	-1	-1
Hovering	5	1	-1	0
Normal Take Off	4	1	0	0
Normal Cruise	5	0	-1	-1
Total	17.0	1	-3	-2
Mean Attenuation	4.25	0.25	-0.75	-0.50

Table VII

Attenuation in Decibels of Soundproofing Material in an Army OH-6A Helicopter as Determined with Octave-Band Analysis of Internal Noise, at the Right Side of the Transmission, Recorded with and without Soundproofing Material Installed.

Octave-Band Center Frequencies in Hertz

	31.5	63	125	250	500	1K	2K	4K	8K	16K
Operating on the Ground	3	3	2	0	3	11	21	16	20	12
Hovering	-1	1	2	1	0	6	15	15	19	14
Normal Take Off	2	0	1	0	0	10	15	14	17	14
Normal Cruise	3	2	6	0	2	9	9	16	20	15
Total	7.0	6	11	1	5	36	60	61	76	55
Mean Attenuation	1.75	1.50	2.75	0.25	1.25	9.00	15.00	15.25	19.00	13.75

Table VIII

Attenuation in Decibels of Soundproofing Material in an Army OH-6A Helicopter as Determined with Measurements of Over-all Internal Noise Spectrum with Four Weighting Networks, at the Right Side of the Transmission, Recorded with and without Soundproofing Material Installed.

	Weighting Networks			
	A	B	C	Lin.
Operating on the Ground	11	5	3	3
Hovering	6	3	2	2
Normal Take Off	8	3	2	2
Normal Cruise	8	4	4	4
Total	33	15	11	11
Mean Attenuation	8.25	3.75	2.75	2.75

Table IX

Attenuation in Decibels of Soundproofing Material in an Army OH-6A Helicopter as Determined with Octave-Band Analysis of Internal Noise, at the Left Side of the Transmission, Recorded with and without Soundproofing Material Installed.

	Octave-Band Center Frequencies in Hertz									
	31.5	63	125	250	500	1K	2K	4K	8K	16K
Operating on the Ground	2	1	2	1	2	11	16	12	17	11
Hovering	-2	3	0	-1	1	10	21	16	16	14
Normal Take Off	3	1	-4	-1	0	9	14	15	16	13
Normal Cruise	3	3	-3	-1	2	12	13	15	19	15
Total	6	8	-5	-2	5	42	64	58	68	53
Mean Attenuation	1.5	2	-1.25	-0.50	1.25	10.50	16.00	14.50	17.00	13.25

Table X

Attenuation in Decibels of Soundproofing Material in an Army OH-6A Helicopter as Determined with Measurements of Over-all Internal Noise Spectrum with Four Weighting Networks, at the Left Side of the Transmission, Recorded with and without Soundproofing Material Installed.

	Weighting Networks			
	A	B	C	Lin.
Operating on the Ground	9	5	3	3
Hovering	10	3	2	1
Normal Take Off	6	0	-1	0
Normal Cruise	8	2	0	2
Total	33	10	4	6
Mean Attenuation	8.25	2.50	1.00	1.50

One way of estimating true attenuation effects is to take an over-all view of the data and note the averaging out effect of experimental artifacts. Tables V through X contain a treatment of the data which reflects the mean values of differences obtained at each of the three positions in the aircraft after all operational conditions were summed. In the bands from 500 Hz center frequency and below, there was fluctuation of values both plus and minus, near zero, with a maximum difference of 2.75 db at 125 Hz center frequency band. In view of these low valued averages, we can say with assurance that the soundproofing material had very little effect at low frequencies. These results are to be expected. This type of sound treatment does not yield much low frequency attenuation.

The five high frequency bands from 1K Hz to 16K Hz show average attenuation values from 4 db up to as much as 19 db among these bands. There is no question of the significance of these larger values and of the attenuation effects. The higher values, of course, were obtained at the two positions near the transmission, which ranged from 9 db through 19 db. Lower values were recorded at the pilot's position. This range was from 4 through 9.75 db.

The attenuation effects indicated by these tests show that there is considerable attenuation around the transmission area and a significant amount

even at the pilot's position, but very little or no protection below 1K Hz band. This partial attenuation of the total noise spectra is considered worthwhile even though it may be seen that the over-all "C" and linearly weighted over-all levels were affected very little.

CONCLUSION AND RECOMMENDATIONS.

As a test of the attenuation effects of soundproofing material in an Army OH-6A helicopter, the Aeromedical Research Unit recorded noise at three positions in the aircraft under four operating conditions. The recordings were made with and without soundproofing material installed. The results show that there was very little effect in the audio spectrum below 1K Hz, but there was significant attenuation in the five high frequency octave bands. The higher values were obtained at the positions around the transmission. However, the measured attenuation at the pilot's position was significant.

Acoustic noise in and around Army aircraft is an unwieldy problem. At this time, the state of knowledge of noise abatement techniques makes it impossible to attenuate the noise levels throughout the audio spectrum without seriously affecting the performance of the aircraft. Any economical process by which attenuation of any portion of the high noise spectrum can be achieved

may be considered beneficial. A partial elimination of the acute acoustic problem is certainly worthwhile. It is therefore recommended that the soundproofing assembly in the OH-6A helicopter be provided as standard equipment.

Army Technical Bulletin T. B. Med 251, 25 January, 1965, requires the initiation of a hearing conservation program when the ambient environmental noise is greater than 92 db in the 150 to 300 Hz octave-band and 85 db in all high octave bands through 9600 Hz. The results of the tests show that, even with the attenuation offered by the soundproofing assembly in the OH-6A, the resultant sound spectrum is not within the safety limits specified by the Surgeon General. The sound pressure levels are considered high enough to require ear protective devices. Even though the internal noise sound pressure levels are excessive in this and other Army aircraft, it is possible to provide the crew with devices that will reduce the effective level at the ears of the personnel to levels below those specified by T. B. Med 251. USAARU Report No. 67-6 on "Sound Attenuation Characteristics of the Army APH-5 Helmet" has shown the standard helmet as an inefficient acoustic insulator. USAARU Reports Nos. 67-8 and 68-6 have shown that the Navy SPH-3 (Modified) and the Navy BPH-2 helmets, respectively, provide relatively high sonic attenuation. It is therefore recommended that one of these

helmets or any helmet or ear protective device, with comparable attenuation characteristics, be provided as standard equipment with this helicopter. The attenuation available with either of these helmets would satisfy the requirements of the T. B. Med 251.

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4. Camp, Robert T., Jr. Sound Attenuation Characteristics of the Navy SPH-2 Helmet. USAARU Report No. 68-6, U. S. Army Aeromedical Research Unit, Fort Rucker, Alabama, March 1968.

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Photographs

INCLOSURE 4

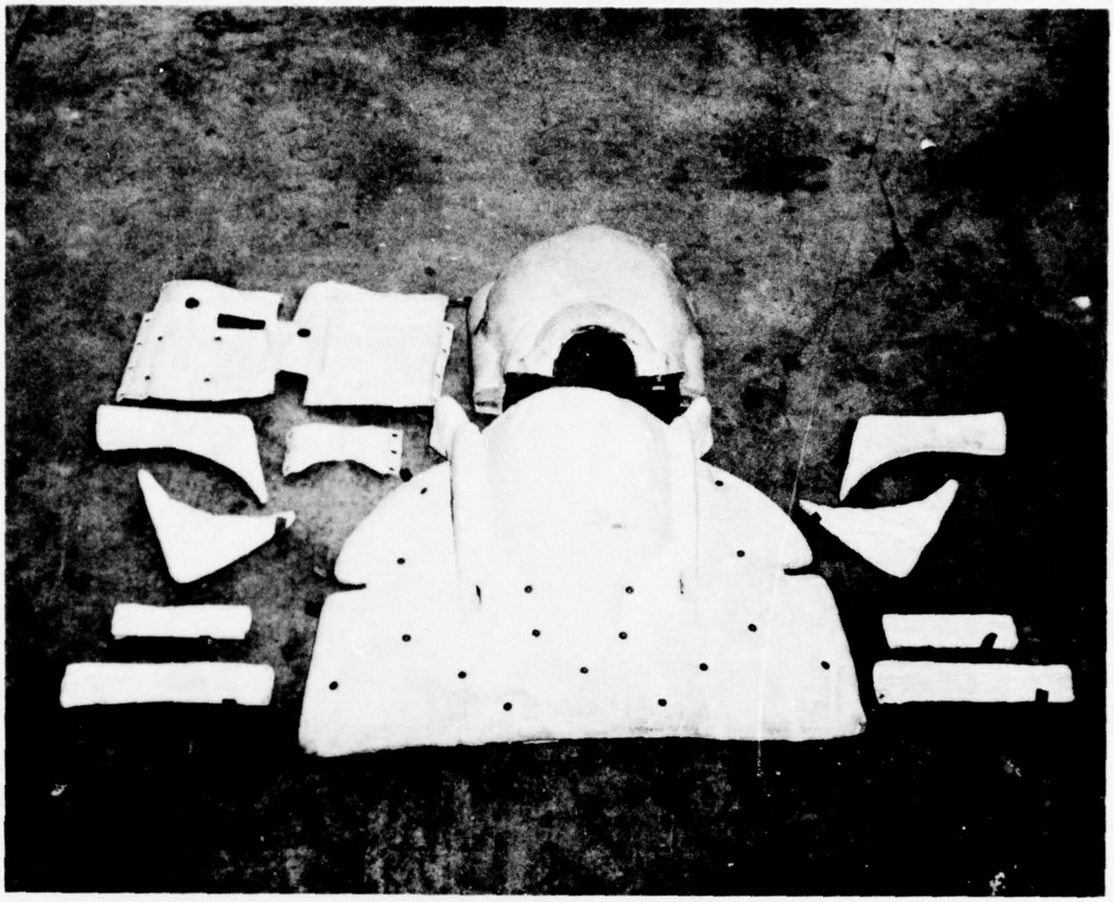


Figure 1

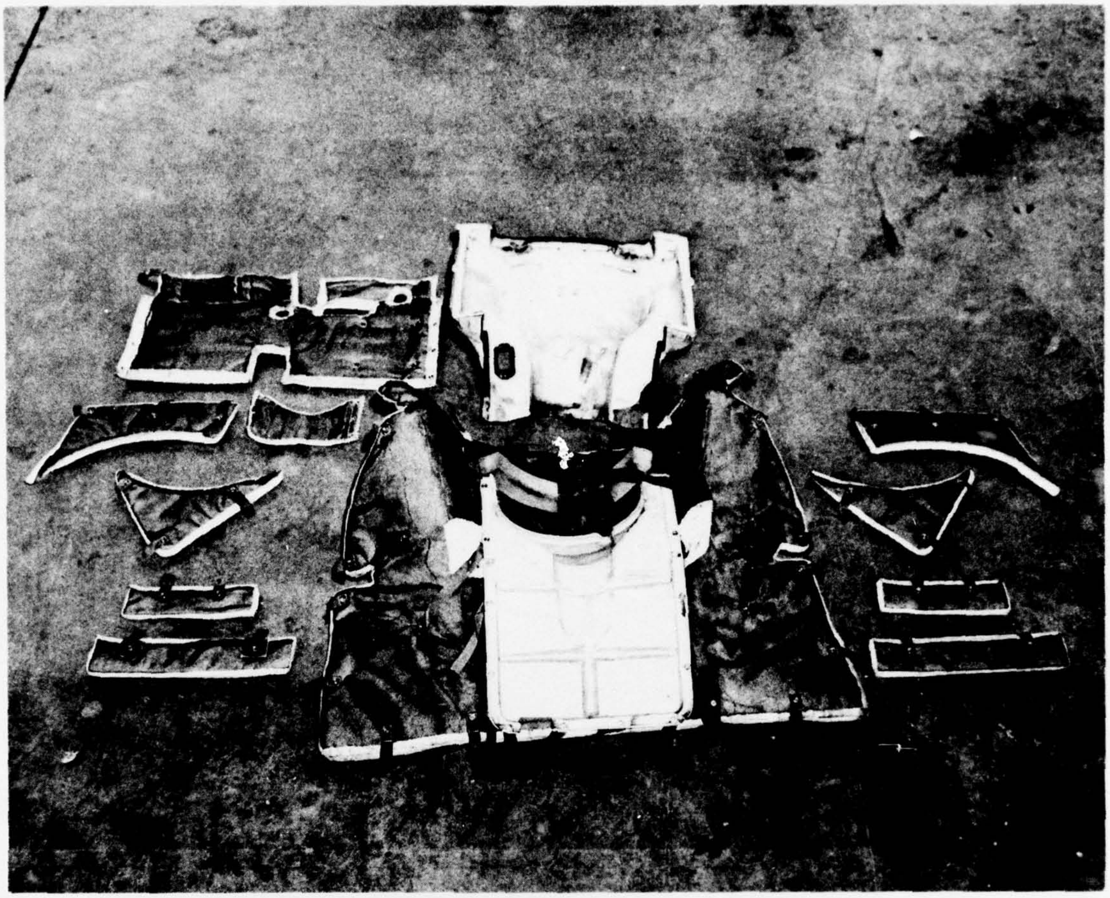
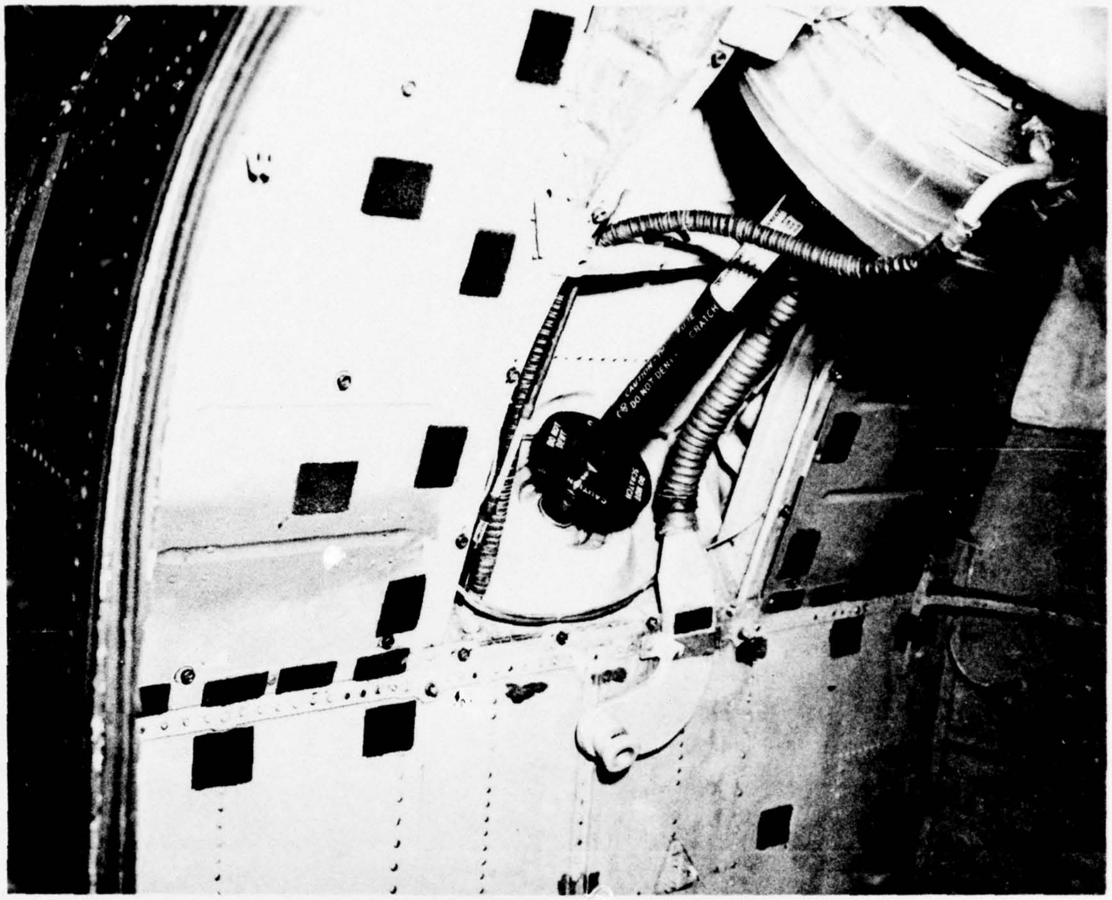


Figure 2



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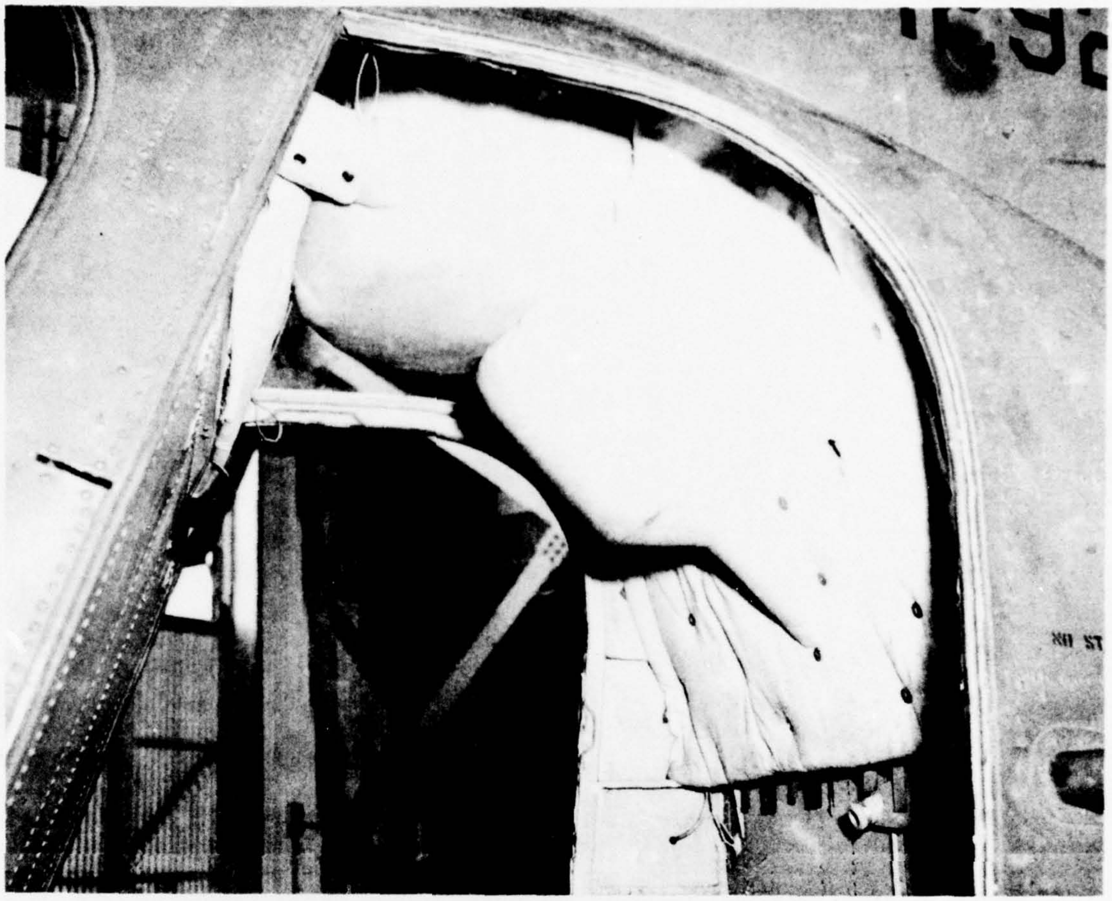

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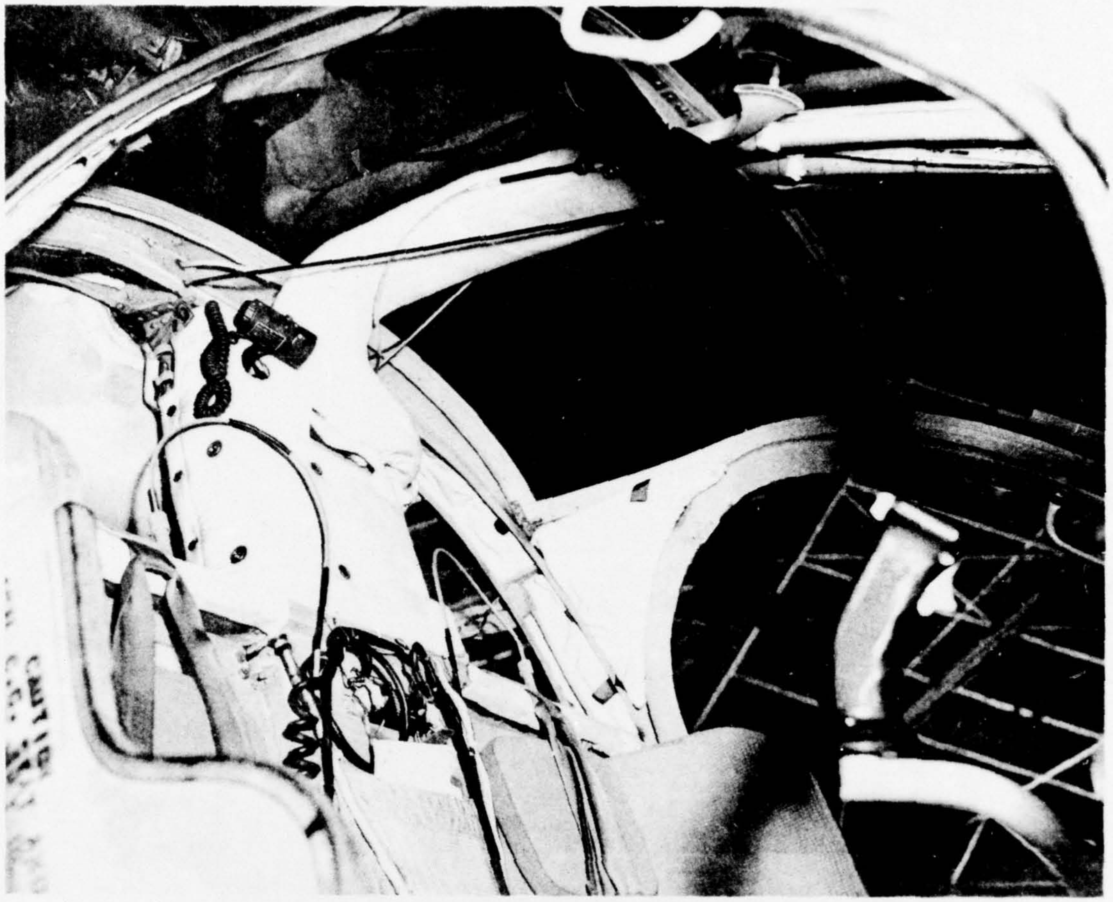

Figure 5

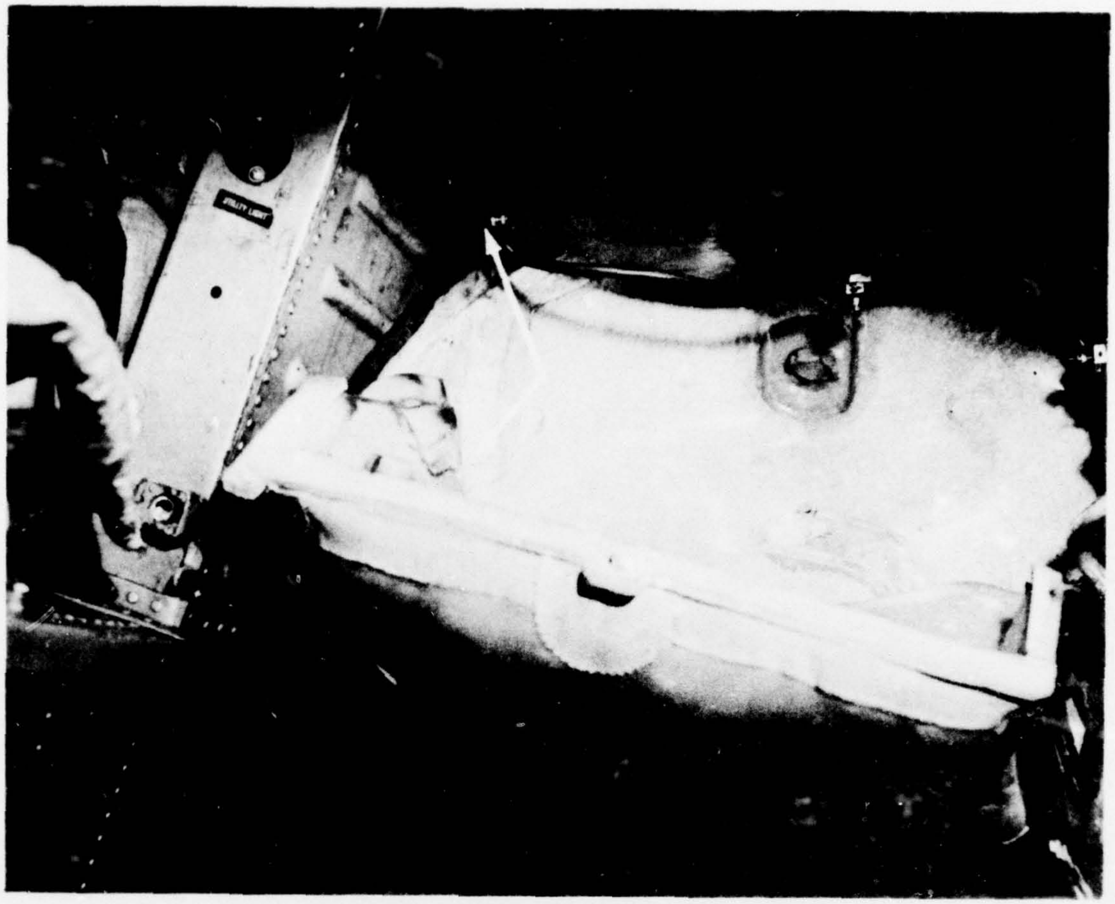

Figure 6